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The Arrow of Time

Philosophy of Time and Time Travel (Dartmouth College)

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The Problem of the Arrow of Time

Summary

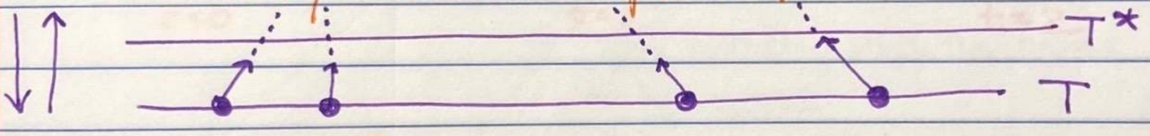
- There exists a conflict b/w physics @ microscale & macroscale

Microscale	Macroscale
Time reversal invariant	Not

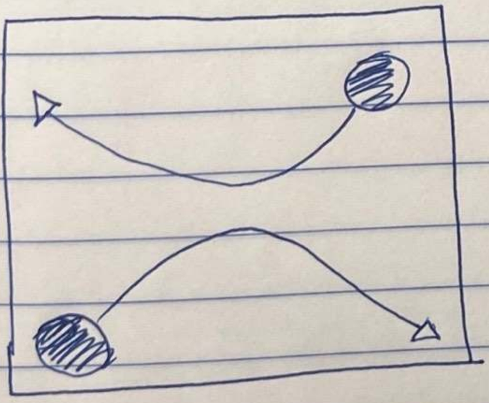
We want to releave the tension b/w those two scales.

Physics @ The microscale:

- Point particles
- Could have mass, charge, position, velocity, etc.
- Newton's law are deterministic
  → Only one future compatible w/ state of universe



- Symmetries ① spatial shifts
  ② temporal shifts
  ③ time reversal ↑↓



Symmetry (balls colliding)

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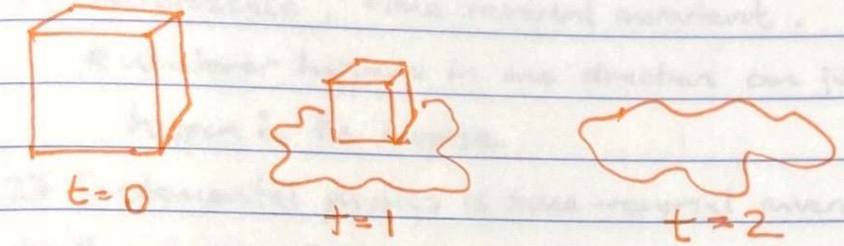
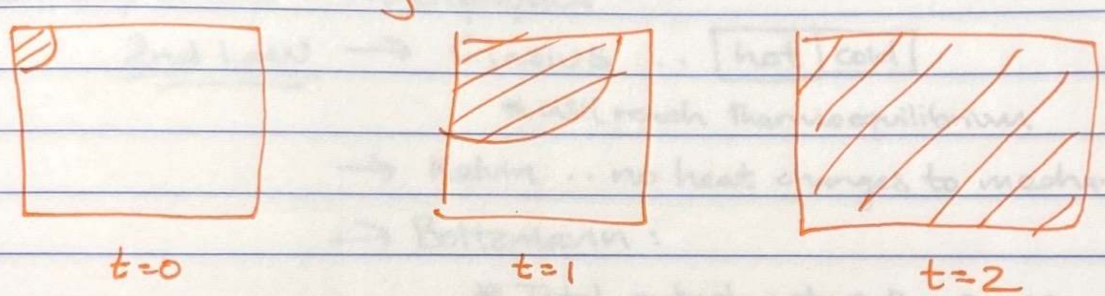
Physics @ the Macroscale



or smoke diffusing



But cubes don't melt in reverse and smoke doesn't collect back @ the corner of the room. Also, people don't age in reverse.

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Problem of Arrow of Time Day 2

Tension b/w macroscale & microscale
- At microscale, time reversal invarient.
  * Whatever happens in one direction can just as well happen in the reverse
- If fundamental physics is time-reversal invarient, why don't we see these things happening in reverse?

Thermodynamics : Macrophysics

2nd Law → Clasius . . . | hot | cold |

* Will reach thermoequilibrium

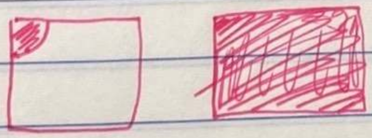
→ Kelvin . . no heat changes to mechanical

→ Boltzmann :

* Total entrophy stays the same or increases

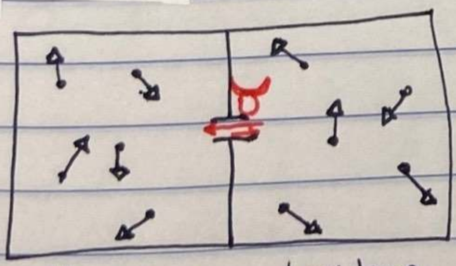
Entropy: a measure of the number of microstates compatible with a given macrostate.

Ex. There are more ways to be a puddle of water on the floor than a well-structured cube of ice.



more chaos associated w/ second picture here

Maxwell's Demon



Temp. = average kinetic energy

Hot gets hotter, cold gets colder

→ Violation of 2nd law

2nd Law isn't absolute law,

/ by and large ... for most part chaos increases

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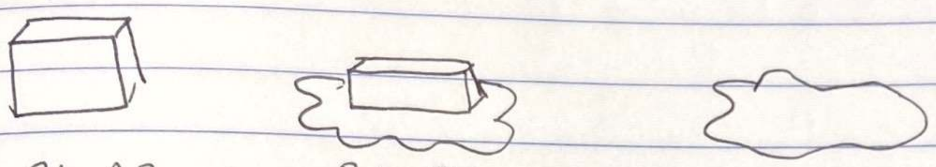

A1, A2 | B1, B2, B3, B4 | C1 ... C16

↓

Possible future states =

A1, A2, C1 ... C16

↓

Likely to evolve to <u>C</u> state

This statistical argument fails.

There are just as many microstates leading to A as there are to C states (cuz every vector set could be reversed)

- 50% melts, 50% forms into a cube

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